Interactive visualization of seismic horizons over the World Wide Web

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ABSTRACT

A framework is developed which allows geoscientists to visualize horizons using remote, network-connected computer systems. This framework employs Virtual Reality Modelling Language (VRML) to describe the horizons so that they may be viewed in 3-D using standard World Wide Web browsing software. A new program is developed to obtain seismic horizons from a commercial interpretation system, translate them to VRML and distribute them via a Web server. The development of a prototype framework shows that it is both feasible and advantageous to convert interpretations to this format and distribute them on the Web.

INTRODUCTION

From hockey scores to interest rates, the World Wide Web has been used to distribute timely information from a variety of sources. As technology improves, types of data more complex than simple figures are making their way across the web. Video clips and real-time audio were early ventures into the technology of sending complex information around the world on the Internet. Now a new form of information is being exchanged on the web – descriptions of interactive virtual worlds. This paper discusses this technology, and how it may be adapted for use in exploration geophysics.

Virtual Reality Modeling Language (VRML) is a language that describes interactive 3-D scenes. VRML is normally used in conjunction with a VRML-supporting web browser. Using these browsers one can retrieve files containing VRML via the Internet, display them in 3-D and interact with them. Interaction is accomplished using a mouse or keyboard to change the viewpoint within the scene. Like traditional web pages, which include links to other web pages, VRML scenes can also contain links. By clicking on web links, special objects in a 3-D scene, one can access any kind of web data including additional 3-D scenes.

VIRTUAL REALITY MODELLING LANGUAGE

The best way to understand VRML is by reviewing a short example. In a VRML file one defines a scene by describing each object contained within the scene. Objects must be constructed from geometric primitives such as polygons, spheres and cones. The 3-D scene shown in Figure 1 was generated using the VRML file in Listing 1. This example file defines two objects: a cone and a cube. In addition to the object definitions, the VRML file also defines a web hyperlink associated with the cone. By clicking on the cone one would follow the hyperlink to the CREWES home page.
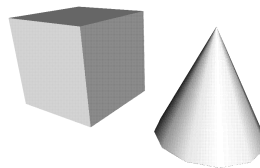

Fig. 1. A simple example of a VRML scene rendered by a VRML-enabled web browser.

The example shown is extremely simple, however VRML is capable of describing extremely complex scenes filled with thousands of polygons.

```
#VRML V1.0 ascii
Separator {
  WWWAnchor {
    name "http://www.crewes.ucalgary.ca/"
    DEF Cone1 Separator {
      Translation {
        translation 0 30 0
      } #Translation
      Cone {
        parts    ALL
        bottomRadius    15
        height          30
      } #Cone
    } #Cone1 Separator
  } #WWWAnchor
  DEF Cube1 Separator {
    Translation {
      translation -45 30 0
    } #Translation
    Cube {
      width   30
      height  30
      depth   30
    } #Cube
  } #Cube1 Separator
} #Separator
```

Listing. 1. The VRML code used to generate Figure 1 (from Clark, 1996).

APPLICATION TO GEOPHYSICS

3-D Seismic surveys are becoming very common in the industry. Due to their complex nature, it is very valuable to be able to view the interpreted horizons in 3-D. VRML is well suited for describing horizons, faults, wells and even surface topography in 3-D.

This VRML work is based on a previous project (Bland, 1993) in which seismic horizons were translated into another 3-D scene definition language: Rayshade. Rayshade's scene description language is different from VRML, however the underlying code required to translate horizons into a mesh of polygons was easily reusable for a VRML generation. The new program reads horizon data directly from Landmark's SeisWorks/3D interpretation package and outputs a VRML file. A sample of a seismic horizon described by an VRML file is shown in Figure 2.
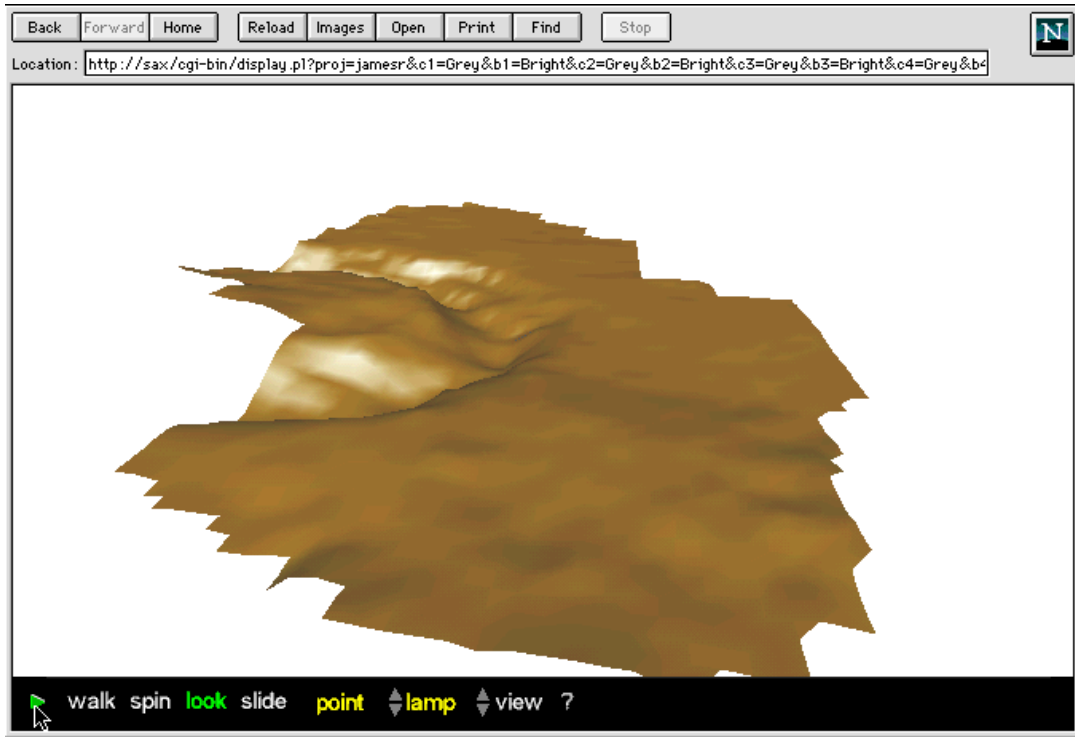
Fig. 2. A sample VRML scene containing an individual seismic horizon (from Isaac, 1993). This horizon was interpreted from a 3-D data volume acquired at James River, Alberta and indicates a possible meteorite impact crater.

The next step of this project was integrating the VRML output with an Internet web browser, such as Netscape Navigator. The horizon-to-VRML translation program was written without a graphical user interface but by using a web browser as a front-end, operation of the program was greatly simplified. Most web browsers support forms which contain user-interface elements like buttons, checkboxes and scrolling lists. Using these forms, a web browser can interact with a web server program. A set of web server scripts were written to generate and process a series of forms, retrieve horizon data from a SeisWorks/3D database and generate VRML files containing the horizons of interest.
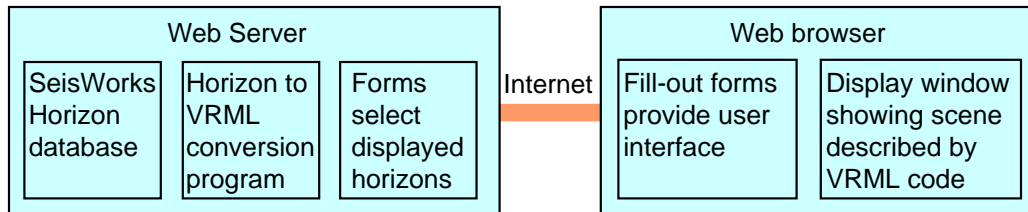

Fig. 3. The framework for 3-D display of SeisWorks/3D horizons using a conventional Web browser.
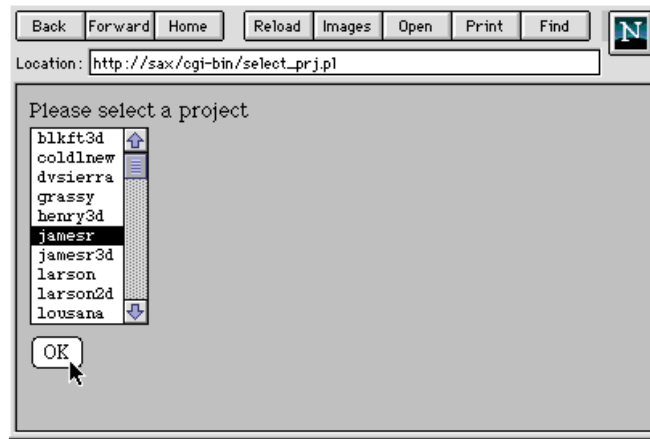
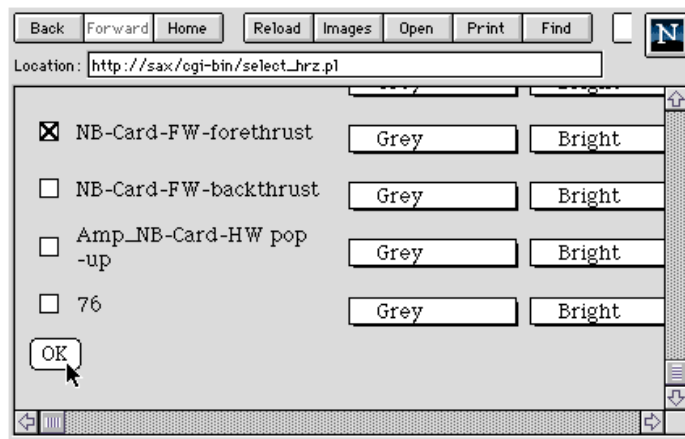Fig. 4. User selects SeisWorks 3D area from a list from within a web browser.

Fig. 5. The desired horizons can be selected from a list. The display colour and brightness is also selectable from a pop-up menu.

Web browser on remote PC		Web server on Interpretation workstation
User clicks on a link for remote horizon display	↘	
	↙	A form containing a list of known projects is generated
User selects a project from the list	↘	
	↙	For the given project, a form containing list of horizons is generated
User selects horizons of interest	↘	
	↙	A VRML scene is generated for the given horizons
User views horizons on screen		

Fig. 5. Interaction between a user on a remote PC, and a web server running on an interpretation workstation. The web server processes a series of forms before generating the desired 3-D scene.

FUTURE WORK

Though useful as a proof-of-concept, the framework we developed for displaying interpretation information is extremely limited. It is missing several key features:

- The display of vertical and horizontal scales.

- Integration of other data types: faults, wells, seismic sections, cultural symbols, surface topology.

- Accurate treatment of intersections between adjacent horizons and/or faults.

- Real-time interaction: switching horizons on/off, changing their surface properties.

- Control over the desired VRML complexity.

In the last year VRML has undergone significant changes. Now at version 2.0, the VRML standard includes support for dynamic scenes and a number of enhancements to its list of base object types. Several new features in VRML 2.0 would be directly applicable to this project. VRML 2.0 supports a height field object type, which would be ideal for representing complex horizons. New support for dynamic scenes could be exploited to allow horizon attributes to be modified in real-time. One could also replace the use of forms to select displayed horizons with an interactive user interface defined within the 3-D scene itself. It is clear that any further development of this project would best be performed using VRML version 2.0

CONCLUSIONS

The technique described for displaying horizons with VRML has a number of useful features:

1) The interpretation may be viewed on systems which do not posses any specialized interpretation software. The software necessary to view these 3-D scenes is available on a number for platforms (including Windows 95, Windows NT and Macintosh). There are several VRML-enhanced web browsers available, and many of them are inexpensive or free.

2) Using the Internet (or a within a corporate intranet), one can gain access to interpretations from a remote site. This is useful both for presentations, and for collaboration on interpretation projects.

3) Using the hyperlink features built into VRML, one could setup a series of inter-linked VRML files containing a variety of data: well logs, surface topology, seismic sections, textual reports or production data. The web browser could be a common access point for data from a variety of sources and disciplines.

VRML has already been used for displaying geological models on the Internet (CSM, 1996). It is hoped that this prototype implementation will encourage development of applications which generate VRML from seismic interpretations.

REFERENCES

Bland, H., 1993: "3-D Visualization of seismic data", CREWES Research Report volume 5.

Bosquet, F., 1996: "SEG/EAEG Modeling Project - The VRML Page", http://www.cwp.mines.edu/~fbosquet/vrml.htlm

Clark, P., 1996: "The easy VRML tutorial", http://www.mwc.edu/~pclark/vrmltut.html

Isaac, H, 1993: "3-D seismic characterization of a cryptoexplosive structure", CREWES Research Report volume 5.